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First
Progress Report

on the
Mechanisms of Fire Ignition and Extinguishment

by
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THE MECHANISMS OF FIRE IGNITION AND EXTINGUISHMENT

1. SUMMARY

The mechanisms of fire ignition and extinguishment are being investigated, with current emphasis on extinguishment by means of dry powders. Powders are being prepared and their physical properties are being measured. Methods of evaluating the effectiveness of powders have been developed and are in use.

2. INTRODUCTION

The current activities of the Defense Department in the development of self propelled missiles have led to the introduction of a variety of new fuels and oxidizing agents with their associated fire hazard problems. This project was initiated to assist in meeting the demand for solutions to these problems. The objective of the investigation is to obtain information on the mechanisms of ignition and extinguishment, with special attention being directed to fires involving propellant materials. Of the various processes employed in fire extinguishment, those involved in the use of dry powders are probably the least understood. Therefore the current effort is being concentrated on the study of the mechanism of extinguishment of flammable-liquid fires by means of dry powders.

3. POWDER PREPARATION AND MEASUREMENT

Various materials are being prepared in finely powdered form for experimental use. Techniques have been established for producing materials of the desired degree of fineness, separating particles of various sizes, and measuring particle sizes. Particle shapes, particle size distribution, and the nature and extent of aggregation are being determined by microscopy.

There are indications that one of the important characteristics of a powder for fire extinguishment is the tendency to become widely distributed when thrown into the air. This property has been called the "dispersibility" of the powder and a method of measuring it has been developed. The details of this method are to be included in a separate report now in preparation.

4. LABORATORY EVALUATION OF POWDERS FOR FIRE EXTINCTION

A laboratory method has been developed for evaluating powders as fire extinguishing agents. Powder is dropped at a controlled rate onto a heptane fire in a small cup. The rate of powder application required for extinguishment is the basis of evaluation and has been measured for two different materials in a number of particle sizes. The details of this method and some results are to be given in a separate report which is being prepared.

5. COMPARISON OF EFFECTIVENESS OF SOLUBLE COMPOUNDS

A technique has been developed for comparing the effectiveness of compounds in arresting flames. A vertical glass cylinder is filled with the desired flammable gases, a fine stainless steel screen is placed in the cylinder at the midpoint, the gases are ignited at the bottom of the cylinder, and the flame front propagates upward. The flame propagation may be arrested if the screen has been previously dipped in one of certain chemical solutions and dried. The weight of dry material on the screen required to arrest the flame has been used as a measure of the effectiveness of the chemical. This method does not require the preparation of a powder.

6. FULL SCALE TESTS

A series of full scale fire tests were conducted to determine the relevance of the laboratory methods of evaluation. The laboratory methods rated materials in the same relative order but implied greater differences than were apparent in full scale tests.

7. SOLID PROPELLANT PROBLEMS

To answer an urgent question within the broader scope of the objectives, a brief study was made of the effects of water, both with and without a wetting agent, on the burning rate of a solid rocket propellant. The details of this study were included in NRL Report 4802 of July 30, 1956. A determination was made of the minimum pressure at which a given rocket propellant would ignite and sustain burning. The products of decomposition of a rocket propellant stored at low pressure are currently being examined.